

**Sustainable and environmentally friendly wood material production for future industrial needs
(SUSWOOD)
2007 Consortium annual report for
KETJU programme, Academy of Finland**

1. Objectives

SUSWOOD project examines the potentials of alternative forest management systems to meet the needs for sustainable production of wood raw material as well as maintaining forest ecosystem functions. A stochastic forest dynamics simulation system using high performance computing will be designed and implemented in order to analyze and quantify the effects of alternative forest management systems, climate conditions, etc. on wood raw material production and its socio-economic implications. This fundamental research will provide scientific knowledge on sustainability of wood raw material production, and their impacts on socio-economics.

2. Consortium

SUSWOOD consortium consists of three projects:

Forestry: Drs. Taneli Kolström (consortium leader) and Julian Lin, Mekrijärvi Research station, University of Joensuu.

Information Technology: Drs. Jan Westerholm and Mats Aspñäs, M.Sc. (Tech) Artur Signell (Ph.D. student), and Messrs Magnus Södergård (1.1-30.6.2007), and Johan Schöring (1.9.2007-), Department of Information Technologies, Åbo Akademi University.

Geography: Dr. Markku Tykkyläinen, M.Sc. Olli Lehtonen (Ph.D. student), Department of Geography, University of Joensuu.

3. Progress in 2007

There are 5 tasks planned in 2007.

	Planned tasks	Tasks been done in 2007	Expected results
F1.1	Statistical model development for modelling tree population dynamics.	<ul style="list-style-type: none"> - Uneven-aged forest experimental data compilation; - Research on dynamic linear models for single-tree simulation; - Research on matrix population dynamic models. - Participate in development of simulation program (object-oriented programming with C++) development. 	<ul style="list-style-type: none"> - A complete set of alternative forest management experimental data for modelling purposes. - Preliminary results on matrix population dynamic models.
F1.2	Study of current and alternatively-managed forest system from the viewpoint of spatial production potentials and efficiency.	<ul style="list-style-type: none"> - GIS map and forest inventory data collection Spatial analysis of inventory data. - Literature review on sustainability issues. 	Complete spatial analysis of intensive forest inventory data from example forest area.
IT1	Parallel programming to implement the tree population model: data decomposition, load balancing and program scalability.	<ul style="list-style-type: none"> - Implemented tree population simulator by using object oriented design with C++ programming language. Include more advanced features such as forest consisting of several independently managed compartments. - Performed code optimization and modified algorithms to improve the performance. - Completed a parallel version of the simulator, capable of concurrently simulating different replications (different random influence) on an arbitrary number of processors. 	<ul style="list-style-type: none"> - Began work on a more sophisticated parallel version which uses domain decomposition and should be able to simulate an arbitrarily large forest. Presently the code consists of about 11000 lines. - Implemented input files in standard XML format. - Designed and implemented a graphical user interface to edit the input parameters to the simulator.
G1.1	Study of current and alternatively-managed forest system from the viewpoint of spatial production potentials and efficiency.	Data collection; grid/local statistics bought from the Statistics Finland;	More data on technological change
G1.2	Demand and supply analysis of forest cluster and related industry on raw wood materials.	I-O model and data obtained and applicability partly tested; additional material commodity statistics; scenario method under consideration	The first article about the forest sector and North Karelia (input-output); the others progressing

4. Modifications to the original research plan

Forestry: Dynamic Linear Models will be used for modelling and simulation of alternative forest managements with large-scale simulations. This modelling approach takes into account the Bayesian updating equations and is more flexible in forecasting forest developments.

Information Technology: Successfully produced a simulator with object-oriented programming approach in C++, based on a simulator developed by Forestry partner, which is capable of simulating approximately 10 million trees in polygonal sub-areas within a forest, and improved the performance by more than 50-fold compared to the reference implementation. This is a revolutionary approach and success in forestry and ecological simulation studies.

Geography: Studying import-substitutions effects (impacts based on those effects).

5. Research outcomes in 2007

Conference and out-reach

Forestry: Metlan talous- ja metsätieteiden yhteistyöseminaari, Koli 29.-30.1.2007; Complex Stand Structures and Associated Dynamics: measurement indices and modelling approaches, July 29 - August 2, 2007, Sault Ste. Marie, Ontario, Canada; Metla Parkano unit (experimental data compilation); Joensuu unit (output analysis); University of Helsinki, SIMO project, simulation software and matrix dynamics simulation; UBC, Canada, forest dynamic modelling and simulation cooperation.

Information Technology: CSC Tieteellinen laskenta; University of Helsinki, SIMO project.

Geography: Annual meeting of Association of American Geographers, San Francisco; Eforwood project meeting in Brussels, European Forest Institute; University of Jyväskylä (Economy/Geography), University of Helsinki at Seinäjoki, University of Helsinki (Economy), ERSA-summary school at Slovakia/Austria; Regional Statistics Group, Regional Council of North Karelia, Joensuu.

Publications

Forestry: Draft articles on simulating large-scale forests with individual trees, forest dynamic modelling of uneven-aged forests.

Information Technology: Draft papers on the forest dynamics simulator in computer science.

Geography: Three research articles (draft): 1. "Forest sector and future in North Karelia", 2. "I-O methodology: the use of location quotients", 3. "Forestry and its effect to the regional living standard"; 1 working paper; "How important is forest sector in North Karelia?"; Other papers (partly analyzed): Regional polarization in North Karelia.

6. Plans for 2008

Forestry: Continuing forest dynamic modelling; simulation testing runs and model parameter calibration; developing statistical models for testing the following hypotheses (according to the original project proposal):

Hypothesis 1. Appropriately introduced competition effects via forest management can increase resistance to abiotic (i.e., storm and draught) damages to forest growth, structure, and productivity.

Hypothesis 2. Uneven-aged forest management systems are environment friendly and they increase sustainability in forest productivity.

Information Technology: Spatial decomposition of the forest, allowing the simulation to be divided up between a very large numbers of processors enabling the simulation of very large forest areas. Inclusion of multiple tree species in the simulator as well as more tree properties and a more advanced tree model. Implementing alternative forest management methods to sub areas of simulated forests. Improvement of the input parameter files so parameters are easier to manage. Paper on the implementation of the simulator. Completion of two master theses in the project.

Geography: Paper on the probability of out-migration from the remotest area (North Karelia) and impact on labour supply in forestry under preparation; Local/micro level investigation focusing on technology, production chains, and impacts; Data on the technology and plans by the forest company; A second researcher Mr. Lauri Korhonen will carry out research tasks in the beginning of 2008.